APPARATUS AND METHOD FOR HEATING AND MELTING SOLID LUBRICANTS IN THE DELIVERY DRUM

The present invention relates to an apparatus and related method for heating and melting solid lubricants (Hot-Melts) in the delivery drum, to allow their transfer by pumping into the containers for servicing oiling machines, specifically electrostatic ones.

Solid lubricants for laminates, known also as "Hot Melts", "Dry-film", "Dry-lube", etc. are solid products at room temperature and their melting point is in the order of 30 ÷ 50 °C.

They are usually delivered in metal drums capable of being fully opened, into which they were poured by the manufacturer.

For their use in electrostatic oiling machines, they must be liquefied by heating beyond the melting point.

This can be obtained in various known manners, for instance using electric shell drum heaters, or introducing the drums themselves into heated chambers and leaving them therein until the content is fully melted.

It is then necessary to move the warm drums and transfer their content into the thermostatic service containers of the oiling machines.

However, this operation is not only impractical, it also requires very long times and a great expenditure of energy.

This is due to the fact the heat conductivity of the solid mass of the lubricant is very poor and therefore the energy applied to the exterior of the container (shell heaters, hot chambers) penetrates very slowly into the mass.

The product near the walls of the drum melts rather rapidly, but the temperature within the solid mass rises at an extremely slow rate, because of the poor heat conductivity of the product and of the absence of convective currents.

The present invention aims to reduce the time required for melting and facilitate transferring the product.

According to the present invention, heating bodies are set down on the upper surface of the solid mass and - progressively sinking into it - they bring thermal energy directly into the core of the mass itself.

As the product melts around the heating bodies, it is animated by convective motions which in turn effectively transmit heat to the adjacent solid mass with progressive expansion of the exchange surface. The liquefaction process thus extends at a growing rate to the entire mass contained in the drum.

When melting is completed, a pump, having its body heated, draws the product from the drum and sends it - through a pipeline, which is also heated - to the service container of the oiling machine.

The apparatus according to the invention described hereafter with reference to Figures 1 and 2 is an effective practical embodiment of these principles.

A heating element constituted by armoured resistors shaped as concentric rings and junction spokes 1 borne by a hoist 2 is set down onto the upper surface of the product 3 to be melted contained in the original drum of the product 4. The heating element is subjected to the thrust deriving from its own weight and that of the connected movable masses

(rod of the hoisting cylinder, load-bearing arms, transfer pump, suction tube, etc.).

At this point the heating element is powered, controlling its temperature by means of a heat sensor 5 applied thereto, at a value T1 sufficient for melting but such as to avoid a harmful local overheating of the product.

Note that the vertical rods 6 that connect the heating elements to the load-bearing arm are not heated: since they remain outside the product for a long time, if they were heated they would rapidly reach very high surface temperatures, such as to damage the product when they entered it.

Under the effect of the heating and of gravity, the heating element starts to sink into the mass that progressively melts around it. The liquefied product - agitated by convective currents - carries the heat and in turn transfers it to the surrounding solid surfaces with a multiplying effect.

When the heating element reaches the bottom dead centre of its travel and is near the bottom of the drum, the entire mass is liquefied with the exception of a few residual nuclei.

The heating element is therefore kept at the temperature T1 for an additional time, in order to allow the entire mass to melt. At this point, temperature control passes to a second sensor 7 mounted on the vertical rods at about one third of their length starting from the bottom, which regulates the maintenance temperature T2. The value T2 is selected slightly above the melting temperature of the product. The product can remain at this temperature T2 even for long times without undergoing any alteration of any kind.

When all the product is liquid, the transfer pump 8 can be started manually or as a result of a command originating from the automation system.

The tube for the delivery of the product 10 is heated for example by circulation of a diathermic fluid within a jacket positioned coaxially.

By way of example, the pump can be started when the signal that the product is totally liquefied and the signal of minimum level in the related service container are both present simultaneously.

The pump is stopped after a time corresponding to the transfer of the entire capacity of the drum. A bottom valve 9 mounted at the foot of the suction tube 11 prevents it from emptying, facilitating the priming of the pump in subsequent operations.

When the drum is empty, the hoist is raised to the top dead centre (see Figure 1b) with a manual command. The empty drum can thus be replaced with a full one and the entire operation can be repeated for a number of times n.

Melting times depend on the heat capacity and on the melting point of the product to be treated, as well as - obviously - on ambient temperature.

By way of example, with ambient temperature 15 °C and melting point of the product of 45 °C, the entire content of the drum is melted in about 5 hours with a power of 3 kW and a temperature of the heating element of 90 °C.

At equal ambient temperature, using a conventional electrical drum heater (shell plus bottom) having a power of 5.5 kW and working temperature of 120 °C, the time for

the complete melting of a drum of Hot-Melt is about 18 hours. Similar times are required by heated chambers. Aside from any energy and economics-related considerations, this length of time is unacceptable.

An oiling machine applying 1 g/m^2 of Hot-Melt on the two surfaces of a 1500 mm wide metal strip at an average speed of 150 m/min. consumes:

2 x 1.5 mm x 1 g/m^2 x 150 m/min = 450 g/min - 0.5 l/min. Therefore, a 200 litre drum is consumed in 400 min, i.e. in less than 7 hours.

Hence, a single-drum heating and melting station would not assure the continuous operation of the line.

The present invention instead assures the continuous operation in most practical cases, with very modest energy requirements.

List of references

1	heating element
2	hoist
3	upper surface of the product
4	drum of the product
5	thermal sensor
6	vertical rods
7	maintenance sensor
8	transfer pump
9	bottom valve
10	pre-heated delivery tube
11	suction tube